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**Group Report****1964-40****H. E. Frachtman****Haystack Pointing System: Sun****29 July 1964**

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Lexington, Massachusetts



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MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
LINCOLN LABORATORY

HAYSTACK POINTING SYSTEM: SUN

*H. E. FRACHTMAN*

*Group 62*

GROUP REPORT 1964-40

29 JULY 1964

LEXINGTON

MASSACHUSETTS

## ABSTRACT

This memorandum describes the method used by the Haystack pointing computer program for obtaining the celestial coordinates of the SUN at any time.

Accepted for the Air Force  
Franklin C. Hudson, Deputy Chief  
Air Force Lincoln Laboratory Office



## I. INTRODUCTION

SUNTRACK is a program in the Haystack Univac 490 pointing system whose output is the celestial coordinates of the Sun at a given time. The program computes the coordinates by 3rd difference interpolation in the tables of the apparent right ascension, declination, and radius vector of the Sun published in The American Ephemeris. The rates of change of the three quantities are computed by numerical differentiation.

## II. INPUTS TO PROGRAM

### A. Inputs Furnished by Core Memory

The program uses the registers listed in Table I for input information. The year and day are used to select the appropriate entries from the Sun's ephemeris. The coordinates of the Sun are interpolated for the time which is the sum of the times in CELTIME AND DELTATEE.

### B. Inputs Furnished by Magnetic Tape

The tape format of the Ephemeris for the Sun, which has been edited and recorded by a 7094 program described in Reference (1), is shown in Fig. 1. Each block of 288 words covers a period of 32 days. The ephemeris for each day required 9 words. The program does not make use of the semi-diameter or the year-month-day words in the block. The tape must be on Unit 1 (normally Servo B).

## III. PROGRAM OUTPUTS

### A. Outputs Left in Core Memory

The apparent celestial coordinates of the Sun, corresponding to the time in the register CELTIME, together with their numerical derivatives, are stored in the appropriate registers, as illustrated in Table II.

### B. Typewriter Outputs

During initialization the SUNTRACK program will type, using the INTERCOM subroutine, certain information concerning the SUN. Items printed are:

C

<u>Register</u>	<u>Contents and Scaling</u>
-----------------	-----------------------------

W(CELTIME)	Days B28
W(DELTA TEE)	Days B28
U(YEAR MONTH)	Year B15 (4 decimal digits)
L(YEAR MONTH)	Month B0
L(DAY)	Day of Year B0

TABLE I  
Core Memory Inputs to SUNTRACK Program

NOTE: Notation "B28" means  
that the binary point is to the  
right of bit 28.

I. D.	$10_d$	Conventional Day Number	0
		14	8
All Zero	Year	Month	Day
		4	0
Right Ascension	B26	radians	
First Difference	Right Ascension	B26	radians
Declination	B26	radians	
First Difference	Declination	B26	radians
Radius Vector	B28	Astronomical Units	
First Difference	Radius Vector	B28	Astronomical Units
Semi-Diameter	B26	radians	

Fig. 1. Magnetic Tape Format for SUN Ephemeris

W(RA)	Apparent Right Ascension B27 in revolutions
W(DEC)	Apparent Declination B27 in revolutions
W(RADIUS)	One's complement of distance from center of earth to surface of Sun B24 in Astronomical units
W(RADOT)	Numerical Derivative of Right Ascension B37 radians/sec.
W(DECDOT)	Numerical Derivative of Declination B37 radians/sec.
W(RADIUSDOT)	Numerical Derivative of Radius Vector B24 nautical miles/sec.

TABLE II  
Core Memory Outputs of SUNTRACK Program

1. Julian Day corresponding to values in YEARMONTH, DAY, and CELTIME (7 digits).
2. Apparent Right Ascension of SUN (Hours, Minutes, Seconds to hundredths).
3. Apparent Declination of SUN (Degrees, Minutes, Seconds to hundredths).
4. Day of Year (Up to 3 digits).
5. Universal Time for which the coordinates are interpolated. It is the time in CELTIME at initialization (Hours, Minutes, Seconds to hundredths).
6. The distance between the centers of the Earth and Sun (Astronomical Units to hundred millionths).
7. The work "SUN".

If, after a search through 9 files on Unit 1 (or the finding of an end of tape mark), the sun ephemerides are not found, the program will type "SUN EPHEMERIS FOR X/Y NOT AMONG FIRST 9 FILES" and will exit to the master control program error return. "X" and "Y" indicate the current month and year, respectively.

If there is a tape servo malfunction during search, the program will type "IIIC STATUS S1 ZZ" and will exit to the master control program error return. The two digit octal number "ZZ" comes from the tape status word and indicates the error condition.

#### IV. ASTRONOMICAL SIGNIFICANCE

The apparent right ascension and declination of the SUN in the ephemerides are referred to the true equinox and equator of date and are corrected for planetary aberration. They are geocentric apparent quantities; the parallax correction is made by the coordinate conversion program (COCON) in the Haystack system. The values in the tables are computed for Ephemeris Time as argument. The equation

$$ET = UT + \Delta T$$

is used to convert from Universal Time to Ephemeris Time. The constant  $\Delta T$ , represented by the number in the register DELTATEE is approximately 35 seconds.

The radius vector is the actual geometric distance in astronomical units between the centers of the Earth and Sun at the stated time.

The number 934.91 is used to convert astronomical units per day to nautical miles per second in the computation of the number in RADIUSDOT.

$$934.91 = \frac{499.005 \times 2.997925 \times 10^5}{1.852 \times 86400}$$

499.005 = number of seconds per astronomical unit

$2.997925 \times 10^5$  = velocity of light in kilometers per second

1.852 = kilometers per nautical mile

86400 = seconds per day

A comprehensive explanation of the ephemerides is given in Reference (2).

## V. PROGRAM DETAILS

The SUNTRACK program is a subroutine of the Haystack Univac 490 pointing program. The initialization section begins at SUNINIT, the working section at SUNCONT. There are several closed subroutines within SUNTRACK. These are: DAYFIND, STATUSCK, INTERPOL, LEFRNDOFF, and ROUNDOFF. A listing of the program is given in Appendix I.

### A. Initialization

The program, upon initialization, stores an RIL instruction in the tape channel internal interrupt register and an RJP STATUSCK instruction in the external interrupt register. The area in core into which the tape data will be read is cleared, together with some additional registers. This is done to make diagnosis easier in case of malfunction.

The SUN Ephemeris entries are serially numbered by the program which generates the magnetic tape (Reference 1). These serial numbers are called "Conventional Day Numbers" (CDN). An arbitrary decision was made to produce and use tapes such that the CDN for 25 April 1963 is zero. The tape search process looks at the first word in each block, therefore, the SUNTRACK program must compute the CDN of the first word of the block containing the entry for the required day.

Using as inputs the year, day of year, and the effect of integral and half-integral values of CELTIME, the program computes the Julian Day number for the typewriter. The ephemerides start and run continuously from 25 April 1963, which has a Julian

Day Number of 2438144.5; this number is subtracted from the computed Julian Day number to find the Conventional Day Number. (It is 6 for 1 May 1963, the first day for which ephemerides tapes were made for the system.)

The first CDN in each block will be given by  $6 + 32n$  where  $n$  is a positive integer or zero. The first CDN in a block is stored in TAPEBLOCK (lower half) and the SUN identification number  $10_d$  is added to generate a tape search comparison word, stored in TAPESEARCH and also in SAFE.

The number in SLOTBLOCK represents the number of the entry in the 32-word block.

If  $1 < \text{SLOTBLOCK} \leq 29$ , only one block need be read in; if not, either the preceding or following tape block should also be read to provide sufficient ephemerides for 3rd order Bessel interpolation for a four-day period.

If the one-or two-block search and read operations are successful, control is regained at NORMAL and the tape is rewound without interrupt or interlock. At this time, SUN ephemerides for either 32 or 64 days are in core memory.

Besselian interpolation of right ascension is done by the INTERPOL subroutine and the interpolated result is converted to hours, minutes, and seconds and stored for type out. Declination and distance are then interpolated and stored for type out. The other quantities which are to be typed out by INTERCOM are set up. Control is transferred to INTERCOM 7 times for the seven line type out, which completes operation of the initialization section of SUNTRACK.

#### B. Working Section

The SUNTRACK working section begins at SUNCONT. Control is transferred to the subroutine DAYFIND which selects the day's ephemeris entry, stores the addresses of the table entries, and computes the interpolation argument  $P$  from the given value of CELTIME. The INTERPOL subroutine is then entered three times for the interpolation of right ascension, declination, radius and their time rates. An amount corresponding to the SUN's radius is subtracted from the interpolated value for accurate radar range

control. All values are converted, scaled and stored properly in core memory and control is transferred to the master control program.

### C. Subroutines

The initialization section of the SUNTRACK program makes use of the INTERPOL, DAYFIND, STATUSCK, LEFRNDOFF, and ROUNDOFF subroutines. The working section uses all except STATUSCK.

#### 1. INTERPOL

The SUNTRACK interpolation subroutine uses Bessel's interpolation formula (Reference 3) for 3rd difference interpolation of the ephemeris. The formula is

$$f_P = f_0 + P\delta f_{1/2} + \frac{P(P-1)}{4} [\delta^2 f_0 + \delta^2 f_1] \\ + \frac{P(P-1)(P-1/2)}{6} \delta^3 f_{1/2}$$

The quantities in the formula are associated with computer registers as follows:

- a. The address of  $f_0$  is in index register 4.
- b. The interpolation argument  $P$  is in register P.
- c.  $\delta f_{1/2}$  is in register GAMMA.
- d.  $P(P-1)$  is in register PSQMP.
- e.  $\delta^2 f_0 + \delta^2 f_1$  is in register DMINB.
- f.  $\frac{P(P-1)}{6}$  is in register PSQMP6.
- g.  $\delta^3 f_{1/2}$  is in register DMIN2CPLB.
- h.  $f_P$  is in the A register at the finish.

The subroutine also performs numerical differentiation using the following formula (Reference 3):

$$hf'_P = \delta f_{1/2} + \frac{2P-1}{4} [\delta^2 f_0 + \delta^2 f_1] \\ + \frac{3P^2 - 3P + 1/2}{6} \delta^3 f_{1/2}$$

At the completion of the subroutine,  $hf'_P$  is stored in the register NUMDERIV.

When the subroutine is entered, Index Register 4 contains the address of  $f_0$  and the register SETINTAD contains the address of  $\delta f_{1/2}$  of the quantity to be interpolated. Index register 3 is used to acquire the other two first difference registers.

## 2. DAYFIND

The DAYFIND subroutine computes the addresses of the ephemeris entries corresponding to the current day. It also computes the interpolation argument P by properly scaling the sum of CELTIME and DELTATEE. The value of P is always positive, even though time be set negative by the system control programs. The number in DAYINDEX, which can be -2, -1, 0, or +1, takes account of the effect of the integral part of CELTIME on the selection of ephemeris entry.

## 3. STATUSCK

The STATUSCK subroutine is entered from the external interrupt register associated with the tape channel when the interrupt occurs. Examination of the status code generates four possible outcomes:

- a. If the code indicates a normal completion (40), control is returned to the program at the interrupted point.
- b. If the code indicates that an end of tape mark was sensed, the tape is rewound and a message indicating failure to find the ephemeris is printed by the typewriter. The message is described in Section III B. Control is passed to the error return of the master control program.
- c. If the code indicates that an end of file mark was sensed, the register IMPERIAL is indexed and tested for the value 9. When less than 9, the next file is searched by passing control to TRYAGAIN. When IMPERIAL equals 9, an end of tape condition is assumed and the action is as described in (b) above.
- d. If the code indicates anything but end of file, end of tape, or normal completion, a tape error has occurred. The message described in Section III B, indicating the type of error is printed by the typewriter and control is passed to the error return of the master control program.

4. LEFRNDOFF

The LEFRNDOFF subroutine left shifts the AQ register the number of places indicated by the contents of index register 5 and rounds the A register.

5. ROUNDOFF

The ROUNDOFF subroutine right shifts the AQ register the number of places indicated by the contents of index register 5 and rounds the A register.

## APPENDIX I

SPURT OUTPUT NO. 210

SUNTRACK

FRACHTMAN\*7/14/64

CARDS	L1 ID	L2 LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
•	00000	SUNTRACK	PROGRAM FRACHTMAN*7/14/64					
•	00001	SOLAR	EQUALS 100					
•	00002	MANITAPE	EQUALS 55					
•	00003	TAPEINPUT	EQUALS 35					
•	00004	EPHEM	MEANS C15*					
•	00005	HENRY	U-TAG SUNCONT*SUINIT					
00006			FD 1*SUNP;	00001	00177	00002		
00007		SUINIT	ENTRY	00002	00322	32514		
00008			ENT A*W(IGNORE)	00003	61000	00000		
00009			STR A*W(MONITAPE)	00004	11030	00766		
00010			ENT A*W(INIERTUP)	00005	15030	00055		
00011			STR A*W(TAPEINPUT)	00006	15030	00035		
00012			ENT B4*877D	00007	12400	01555		
00013			CL A*	00010	11000	00000		
00014			STR A*W(YRREMAIN+B4)	00011	15034	01413	1ST TEMP STORAGE	
00015		ERASE	B4*ERASE	00012	72400	00011		
00016			ENT A*W(YEARMONTH)	00013	11020	63147		
00017			SUB A*1961D	00014	21000	03651		
00018			STR A*W(MONTHPRINT)	00015	15030	00746		
00019			RSH AQ*30D	00016	03000	00036		
00020			DIV 4	00017	23000	00004		
00021			STR A*W(YRREMAIN)	00020	15030	01413	(0,1,2,3)	
00022			MUL 1461D	00021	22000	02665		
00023			STR Q*W(WHOLEYEAR)	00022	14030	01414		
00024			ENT Q*W(YRREMAIN)	00023	10030	01413		
00025			MUL 365D	00024	22000	00555		
00026			RPL Y+Q*W(WHOLEYEAR)	00025	34030	01414		
00027			RJP DAYFIND	00026	65000	00274		
00028			ENT Q*W(TAPEBLOCK)	00027	10030	01417		
00029			LSH Q*5	00028	05000	00005		
00030			ADD Q*6	00031	26000	00006		
00031			ADD Q*W(IDENT)	00032	26030	00771		
00032			STR Q*W(SAFE)*SKIP	00033	14130	01430		
00033			ENT Q*W(SAFE)	00034	10030	01430		
00034		TRYAGAIN	STR Q*W(TAPESEARCH)	00035	14030	01421		
00035			ENT Q*29D	00036	10000	00035		
00036			ENT A*1	00037	11000	00001		
00037			C0M AQ*W(SLOTBLOCK)*YIN	00040	04430	01420		
00038			JP NOTIN	00041	61000	00510		
00039			IN EPHEM*W(EPHEMB)	00042	73670	00541		

## SUNTRACK

FRACHTMAN\*7/14/64

CARDS	L1	ID	LABEL	TA	STATEMENT	LUC	F	JKB	Y	NOTES
*	000050					00043	12000	00000		
*	000051					00044	13670	00765		
*	000052					00045	12000	00000		
*	000053					00046	13670	01421		
*	000054					00047	61000	00047		
*	000055		NORMAL			00050	13670	00770		
*	000056					00051	12410	01422		
*	000057					00052	11010	01425		
*	000058					00053	15010	01053		
*	000059					00054	65000	01054		
*	000060					00055	10700	00000		
*	000061					00056	21630	01004		
*	000062					00057	20030	01004		
*	000063					00060	03000	00033		
*	000064					00061	23030	00773		
*	000065					00062	14030	00624		
*	000066					00063	10000	00000		
*	000067					00064	03000	00027		
*	000070					00065	23030	00774		
*	000071					00066	14030	00627		
*	000072					00067	03000	00036		
*	000073					00070	22030	00772		
*	000074					00071	07200	00002		
*	000075					00072	20000	00001		
*	000076					00073	15030	00632		
*	000077					00074	12410	01423		
*	000100					00075	11010	01426		
*	000101					00076	15010	01053		
*	000102					00077	65000	01054		
*	000103					00100	15030	00712		
*	000104					00101	10600	00000		
*	000105					00102	15040	00000		
*	000106					00103	03000	00026		
*	000107					00104	23030	00774		
*	00110					00105	14030	00657		
*	00111					00106	10000	00000		
*	00112					00107	03000	00030		
*	00113					00110	23030	01000		
*	00114					00111	14030	00662		
*	00115					00112	03000	00036		
*	00116					00117	03000	00000		

## SUNTRACK

FRACHTMAN#7/14/64

CARDS	L1	ID	LABEL	TA	STATEMENT	LOC	F	JKB	Y	NOTES
*					MUL W(SARAD)	00113	22030	01001		
*					LSH AQ*2*QPØS	00114	07200	00002		
*					ADD A*1	00115	20000	00001		
*					STR A*W(DLN6)	00116	15030	00665		
*					ENT A*W(GMT2)*ANEQ	00117	11730	00712		
*					JP \$+3	00120	61000	00123		
*					ENT A*W(DLN2)	00121	11030	00657		
*					STR A*CPW(DLN2)	00122	15070	00657		
*					ENT A*W(CELTIME)	00123	11030	63133		
*					ENT Q*Ø*APØS	00124	10600	00000		
*					CP A*	00125	15040	00000		
*					RSH AQ*26D	00126	03000	00032		
*					DIV W(HDAY)	00127	23030	00775		
*					STR Q*W(GMT2)	00130	14030	00712		
*					CL Q*	00131	10000	00000		
*					RSH AQ*23D	00132	03000	00027		
*					DIV W(MDAY)	00133	23030	00776		
*					STR Q*W(GMT4)	00134	14030	00715		
*					RSH AQ*30D	00135	03000	00036		
*					MUL W(SDAY)	00136	22030	00777		
*					LSH AQ*2*QPØS	00137	07200	00002		
*					ADD A*1	00140	20000	00001		
*					STR A*W(GMT6)	00141	15030	00720		
*					ENT A*W(CELTIME)*ANEQ	00142	11730	63133		
*					JP \$+3	00143	61000	00146		
*					ENT A*W(GMT2)	00144	11030	00712		
*					STR A*CPW(GMT2)	00145	15070	00712		
*					ENT B4*L(DISTAD)	00146	12410	01424		
*					ENT A*L(DISTDIFAD)	00147	11010	01427		
*					STR A*L(SETINTAD)	00150	15010	01053		
*					RJP INTERPØL	00151	65000	01054		
*					STR A*W(INITIAL18)	00152	15030	00733		
*					ENT A*W(JULIANDAY)	00153	11030	01415		
*					STR A*W(INITIAL3)	00154	15030	00570		
*					ENT A*L(DAY)	00155	11010	63150		
*					STR A*W(INITIAL12)	00156	15030	00601		
*					RJP U(INTERCØM)	00157	65020	63426		
*					U-TAG INITIALJD*Ø	00160	00560	00000		
*					RJP U(INTERCØM)	00161	65020	63426		
*					U-TAG RHTASC*Ø	00162	00602	00000		
*						00167				

## SUNTRACK

## FRACHTMAN#7/14/64

CARDS	LI ID	LABEL	TA STATEMENT	LJC	F	JKB	Y	NOTES
*	00170		RJP U(INTERCØM)	00163	65020	63426		
*	00171		U-TAG DLN*Ø	00164	00635	00000		
*	00172		RJP U(INTERCØM)	00165	65020	63426		
*	00173		U-TAG INITIALDAT*Ø	00166	00571	00000		
*	00174		RJP U(INTERCØM)	00167	65020	63426		
*	00175		U-TAG GMT*Ø	00170	00670	00000		
*	00176		RJP U(INTERCØM)	00171	65020	63426		
*	00177		U-TAG INITIALDIS*Ø	00172	00723	00000		
*	00200		RJP U(INTERCØM)	00173	65020	63426		
*	00201	AIRPORT	U-TAG INITIALBD*Ø	00174	00734	00000		
*	00202		RPL Y+1*L(SUNINIT)	00175	36010	00002		
*	00203		JP A	00176	61070	00000		
*	00204	SUNCONT	ENTRY	00177	61000	00000		
*	00205		RPL Y+1*L(SUNCONT)	00200	36010	00177		
*	00206		RJP DAYFIND	00201	65000	00274		
*	00207		ENT B4*L(RAAD)	00202	12410	01422		
*	00210		ENT A*L(RADIFAD)	00203	11010	01423		
*	00211		STR A*L(SETINTAD)	00204	15010	01053		
*	00212		RJP INTERPØL	00205	65000	01054		
*	00213		RSH AQ*3ØD	00206	03000	00036		
*	00214		MUL W(REVSRADIAN)	00207	22030	00764		
*	00215		JP MØUSE*QPØS	00210	60200	00212		
*	00216		ADD A*1	00211	20000	00001		
*	00217	MØUSE	STR A*W(RA)	00212	15030	63002		
*	00220		ENT Q*W(NUMDERIV)	00213	10030	01045		
*	00221		MUL W(DRSEC)	00214	22030	01003		
*	00222		ENT B5*4	00215	12500	00004		
*	00223		RJP RØUNDØFF	00216	65000	01403		
*	00224		STR A*W(RADØT)	00217	15030	63007	B37	RADS/SEC
*	00225		ENT B4*L(DECAD)	00220	12410	01423		
*	00226		ENT A*L(DECDFAD)	00221	11010	01426		
*	00227		STR A*L(SETINTAD)	00222	15010	01053		
*	00230		RJP INTERPØL	00223	65000	01054		
*	00231		RSH AQ*3ØD	00224	03000	00036		
*	00232		MUL W(REVSRADIAN)	00225	22030	00764		
*	00233		JP NEGDEC*ANEG	00226	60700	00505		
*	00234		JP BEAVER*QPØS	00227	60200	00231		
*	00235		ADD A*1	00230	20000	00001		
*	00236	BEAVER	STR A*W(DEC)	00231	15030	63003		
*	00237		ENT Q*W(NUMDERIV)	00232	10030	01045		

## FRACHITMAN#7/14/64

## SUNTRACK

CARDS	L1	ID	LABEL	TA	STATEMENT	LOC	F	J	K	S	Y	NOTES
00240	*			MUL	W(IRDRSEC)	00233	22030	01003				
00241	*			ENT	B5*4	00234	12500	00004				
00242	*			RJP	RØUNDØFF	00235	65000	01403				
00243	*			STR	A*W(DECØT)	00236	15030	63010	B37	RADS/SEC		
00244	*			ENT	B4*L(DISTAD)	00237	12410	01424				
00245	*			ENT	A*L(DISTIFAD)	00240	11010	01427				
00246	*			STR	A*L(SETINTAD)	00241	15010	01053				
00247	*			RJP	INTERPØL	00242	65000	01054				
00250	*			RSH	AQ*4*QPOSS	00243	03200	00004				
00251	*			ADD	A*1	00244	20000	00001				
00252	*			SUB	A*W(SUNRAD)	00245	21030	01005				
00253	*			CP	A*	00246	15040	00000				
00254	*			STR	A*W(RADIUS)	00247	15030	63006				
00255	*			ENT	Q*W(NUMDERIV)	00250	10030	01045				
00256	*			MUL	W(AUDNMSEC)	00251	22030	01002				
00257	*			ENT	B5*7	00252	12500	00007	SUN			
00260	*			RJP	LEFRNDØFF	00253	65000	01373				
00261	*			STR	A*W(RADIUSDØT)	00254	15030	63011	B24	NM/SEC		
00262			SEAPØRT	EXIT		00255	61010	00177				
00263			FLATNEG	CP	A*	00256	15040	00000				
00264	*			SUB	A*W(HALFDAY)*APØS	00257	21630	00763				
00265	*			JP	LESSØNE	00260	61000	00272				
00266	*			RSH	AQ*3ØD	00261	03000	00036				
00267	*			DIV	W(HALFDAY)	00262	23030	00763				
00270	*			LSH	AQ*3ØD	00263	07000	00036				
00271	*			SUB	A*1	00264	21000	00001				
00272	*			JP	TWØLESS*AZERO	00265	60400	00270				
00273	*			JP	TWØLESS*ANEG	00266	60700	00270				
00274	*			ENT	A*-3*SKIP	00267	11140	77774				
00275	*			ENT	A*-2	00270	11040	77775				
00276	*			JP	STØRE	00271	61000	00334				
00277	*			ENT	A*-1	00272	11040	77776				
00300	*			JP	STØRE	00273	61000	00334				
00301	*		DAYFIND	ENTRY		00274	61000	00000				
00302	*			ENT	A*W(CELTIME)	00275	11030	63133				
00303	*			ADD	A*W(DELTAEE)*APØS	00276	20630	63316				
00304	*			JP	NEGTIME	00277	61000	00311				
00305	*			LSH	A*1*APØS	00300	06600	00001				
00306	*			SUB	A*W(KEY)*SKIP	00301	21130	01017				
00307	*			STR	A*W(P)*SKIP	00302	15130	01026				

SPURT OUTPUT NO. 210

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CARDS	LI ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
•	00310		STR A*W(P)*SKIP	00303	15130	01026		
•	00311		ENT A*0*SKIP	00304	11100	00000		
•	00312		ENT A*1	00305	11000	00001		
•	00313		JP TIMESLIDE	00306	61000	00317		
•	00314	DAYINDEX	0	00307	00000	00000		
•	00315	DAYINCREMENT		00310	00000	00000		
•	00316	NEGTIME		02311	06600	00001		
•	00317		LSH A*1*AP0\$	00312	21130	01017		
•	00318		SUB A*W(KEY)*SKIP	00313	15130	01026		
•	00319		STR A*W(P)*SKIP	00314	15130	01026		
•	00320		STR A*W(P)*SKIP	00315	11140	77775		
•	00321		ENT A*-2*SKIP	00316	11040	77776		
•	00322		ENT A*-1	00317	15030	00307		
•	00323		STR A*W(DAYINDEX)	00320	11630	63133		
•	00324		ENT A*W(CELTIME)*AP0\$	00321	61000	00256		
•	00325		JP FLATNEG	00322	21630	00763		
•	00326		SUB A*W(HALFDAY)*AP0\$	00323	61000	00272		
•	00327		JP LESSONE	00324	03000	00000	300	
•	00328		RSH AQ*	00325	23030	00763		
•	00329		JP W(HALFDAY)	00326	07000	00036		
•	00330		LSH AQ*300	00327	21000	00001		
•	00331		SUB A*1	00330	60400	00333		
•	00332		JP CERO*AZERO	00331	60700	00333		
•	00333		JP CERO*ANEG	00332	11100	00001		
•	00334		ENT A*1*SKIP	00333	11000	00000		
•	00335		JP CERO	00334	15030	00310		
•	00336		ENT A*0	00335	20030	01414		
•	00337		ENT A*1	00336	20030	03172	JD DEC 31 1960 GNWCH N00N	
•	00338		STR A*W(DAYINCREMENT)					
•	00339		ADD A*W(WHOLEYEAR)					
•	00340		ADD A*24373000					
•	00341	STORE						
•	00342							
•	00343							
•	00344		ADD A*1(DAY)	00337	20010	63150		
•	00345		STR A*W(JULIANDAY)	00340	15030	01415		
•	00346		ADD A*W(DAYINDEX)	00341	20030	00307		
•	00347		SUB A*24381510	00342	21030	03173		
•	00350		SUB A*W(DAYINCREMENT)	00343	21030	00310		
•	00351		RSH AQ*300	00344	03000	00036		
•	00352		DIV 320	00345	23000	00440		
•	00353		STR Q*W(TAPEBLOCK)	00346	14030	01417		
•	00354		STR A*W(SL0TBLOCK)	00347	15030	01420		
•	00355		ENT Q*W(SL0TBLOCK)	00350	10030	01420		
•	00356		MUL 11	00351	22000	00011		

## FRACHTMAN#7/14/64

CARDS	L1	ID	LABEL	TA	STATEMENT	LOC	F	JKB	Y	NOTES
*	00357			ADD	Q*AEPHEM+2)0D	00352	26000		02073	
*	00360			STR	Q*L(RAAD)	00353	14010		01422	
*	00361			ADD	Q*I	00354	26000		00001	
*	00362			STR	Q*L(RADIFAD)	00355	14010		01425	
*	00363			ADD	Q*I	00356	26000		00001	
*	00364			STR	Q*L(DECAD)	00357	14010		01423	
*	00365			ADD	Q*I	00360	26000		00001	
*	00366			STR	Q*L(DECDFIFAD)	00361	14010		01426	
*	00367			ADD	Q*I	00362	26000		00001	
*	00370			STR	Q*L(DISTAD)	00363	14010		01424	
*	00371			ADD	Q*I	00364	26000		00001	
*	00372			STR	Q*L(DISTDIFAD)	00365	14010		01427	
*	00373			EXIT		00366	61010		00274	
*	00374			ENTRY	EPHEM*W(TAPSTAT)	00367	61000		00000	
*	00375			ENT	A*W(TAPSTAT)	00370	17670		00502	
*	00376			RSH	A*11D	00371	11020		00502	
*	00377			STR	A*W(TAPSTAT+1)	00372	02000		00013	
*	00400			RPL	Y+1*L(STATUSCK)	00373	15030		00503	
*	00401			ENT	B3*L(TAPSTAT+1)	00374	36010		00367	
*	00402			RIL		00375	12310		00503	
*	00403			JP	STATACT+B3	00376	60000		00000	
*	00404			JP	BUST	00377	61003		00400	
*	00405			JP	BUST	00400	61000		00454	
*	00406			JP	BUST	00401	61000		00454	
*	00407			JP	BUST	00402	61000		00454	
*	00410			JP	BUST	00403	61000		00454	
*	00411			JP	BUST	00404	61000		00454	4 SEQ ERR SYNC 20
*	00412			JP	BUST	00405	61000		00454	5 REWINDING 24
*	00413			JP	BUST	00406	61000		00454	6 CHAR COUNT 30
*	00414			JP	BUST	00407	61000		00454	7 ILLEGAL 34
*	00415			EXIT		00410	61010		10 40 NORMAL	
*	00416			JP	BUST	00411	61000		00454	11 REPEAT 44
*	00417			JP	BUST	00412	61000		00454	12 SEQ ERR COUNT 50
*	00420			JP	ENDFILE	00413	61000		13 EOF 54	
*	00421			JP	CANTFIND	00414	61000		14 EOF 60	
*	00422			JP	BUST	00415	61000		15 NONSUCH	
*	00423			JP	BUST	00416	61000		16 ABN F C 70	
*	00424			JP	BUST	00417	61000		17 INTERLOCK 74	
*	00425		CANTFIND	EX-FCT	EPHEM*W(REWINDNO)	00420	13670		00770	
*	00426			ENT	B4*L(MONTHPRINT)	00421	12410		00746	

## SUNTRACK

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CARDS	LI ID	LABEL	TA STATEMENT	LDC	F	JKB	Y	NOTES
*			ENT A**W(YEARPRINT+B4)	004422	11034	01006		
*	00430		STR A**W(NDATA2)	004423	11030	00551		
*	00431		ENT B4*L(YEARMONTH)	004424	12410	63147		
*	00432		ENT A**W(MONTHPRINT+B4)	004425	11034	00746		
*	00433		RPL A+Y**W(NDATA2)	004426	24032	00551		
*	00434		CL A*	004427	11000	00000		
*	00435		ENT Q**L(BARRIER)	004430	10010	00451		
*	00436		DIV 12	004431	23000	00012		
*	00437		ADD A**60	004432	20000	00060		
*	00438		STR A**U(IMPERIAL)	004433	15020	01416		
*	00441		CL A*	004434	11000	00000		
*	00442		DIV 12	004435	23000	00012		
*	00443		JP ALBERT*ALERO	004436	60400	00440		
*	00444		ADD A**60	004437	20000	00060		
*	00445	ALBERT	LSH A**6	004440	26000	00006		
*	00446		ADD A**U(IMPERIAL)	004441	20000	01416		
*	00447		LSH A**6	004442	26000	00006		
*	00450		ADD A**3105000005	004443	20030	03174		
*	00451		STR A**W(NDATA3)	004444	15030	00555		
*	00452		RJP U(INTERCOM)	004445	65020	63426		
*	00453		U-TAG NODATA*0	004446	20543	00000		
*	00454		JP LISUNUNIT	004447	61010	00002		
*	00455	ENDFILE	RPL Y+L*(IMPERIAL)	004450	36010	01416		
*	00456	BARRIER	SUB A**11	004451	21000	00011	SUN	
*	00457		JP CANTFIND*ALERO	004452	60400	00420		
*	00460		JP TRYAGAIN	004453	61000	00034		
*	00461	BUST	EX-FCT EPHEM*W(REWINDW)	004454	13670	00770		
*	00462		ENT A**L(TAPSTAT+1)	004455	11010	00503		
*	00463		RSH A**1	004456	20200	00001		
*	00464		ADD A**60	004457	20000	00000		
*	00465		LSH A**6	004460	26000	00000		
*	00466		STR A**L(TAPSTAT+2)	004461	15010	00004		
*	00467		ENT A**L(TAPSTAT+1)	004462	11010	00003		
*	00470		SEL CL*X77776	004463	52040	77776		
*	00471		LSH A**2	004464	22060	00000		
*	00472		ADD A**60	004465	20000	00000		
*	00473		ADD A**L(TAPSTAT+2)	004466	20010	00004		
*	00474		STR A**L(TAPEBUST+3)	004467	15010	00000		
*	00475		RJP U(INTERCOM)	004470	65020	63426		
*	00476		U-TAG TAPEBUST*0	004471	00473	00000		

SUNTRACK

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CARDS	LI ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
*	00477		JP L(SUNINIT)		00472	61010	00002	
*	00500	TAPEBJST	FD J*A		00473	06050	50505	
*	00511		-0 TAPEBUSTI		00474	77777	00475	
*	00502	TAPEBUSTI	FD J*111C		00475	16161	01005	
*	00503		FD J*STATU		00476	30310	63132	
*	00504		FD 2*S SI		00477	30050	53061	
*	00505		-0 -0		00500	05050	50500	
*	00506	TAPSTAT	+0 +0		00501	77777	77777	
*	00507		+0		00502	00000	00000	
*	00510		JP BEAVER*QNEG		00503	00000	00000	
*	00511	VEGDE	JP SUB A*1		00504	00000	00000	
*	00512		JP BEAVER		00505	60300	00231	
*	00513		ADD A*1		00506	00000	00000	
*	00514	NOTIN	JP SUB A*W(SLOTBLOCK)		00507	61000	00231	
*	00515		JP BLOCKAY*AP0S		00510	20000	00001	
*	00516		IN EPHEM*W(EPHEM)		00511	21030	01420	
*	00517	BLOCKSEE	NO-JP		00512	00600	00530	
*	00520		EX-FCT EPHEM*W(SRHIBIN)		00513	73670	00541	
*	00521		NO-JP		00514	12000	00000	
*	00522		EX-FCT EPHEM*W(TAPESEARCH)		00515	13670	00765	
*	00523		EX-FCT EPHEM*W(EPHEM)		00516	12000	00000	
*	00524		JP \$ IN EPHEM*W(EPHEM)		00517	13670	01421	
*	00525		ENT A*40		00520	61000	00520	
*	00526	PATCH	EX-FCT EPHEM*W(SRHIBIN)		00521	73670	00542	
*	00527		RPL A+Y*W(TAPESEARCH)		00522	11000	00040	
*	00530		EX-FCT EPHEM*W(TAPESEARCH)		00523	13670	00765	
*	00531		JP \$		00524	24030	01421	
*	00532		JP NORMAL		00525	13670	01421	
*	00533		00526		00526	61000	00526	
*	00534	BLOCKAY	IN EPHEM*W(EPHEM)		00527	61000	00050	
*	00535		ENT A*-40		00530	73670	00540	
*	00536		EX-FCT EPHEM*W(SRHIBIN)		00531	11040	77737	
*	00537		RPL A+Y*W(TAPESEARCH)		00532	13670	00765	
*	00540		EX-FCT EPHEM*W(TAPESEARCH)		00533	24030	01421	
*	00541		JP \$		00534	13670	01421	
*	00542		IN EPHEM*W(EPHEM)		00535	61000	00535	
*	00543	PATCH	JP PATCH		00536	73670	00541	
*	00544	EPHEMA	U-TAG AEPHEM+287D*AEPHEM		00537	61000	00522	
*	00545	EPHEMB	U-TAG AEPHEM+575D*AEPHEM+288D		00540	62070	01431	
*					00541	02530	02071	

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CARDS	L1 ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
•	00546	EPHEM	U-TAG AEPHEM+863D*AEPHEM+576D	00542	03170	02531		
•	00547	N0DATA	FD Ø*A	00543	06050	50505		
•	00550		-Ø N0DATA1	00544	77777	00545		
•	00551	N0DATA1	FD Ø*SUN E	00545	30322	30512		
•	00552		FD Ø*PHEM	00546	25151	22212		
•	00553		FD Ø*RIS F	00547	27163	00513		
•	00554		FD Ø*VR	00550	24270	50505		
•	00555	N0DATA2	FD Ø*63/63	00551	66637	46663		
•	00556		FD Ø* N0T	00552	05232	43105		
•	00557		FD Ø*AMONG	00553	06222	42314		
•	00560		FD Ø* FIRS	00554	05131	62730		
•	00561	N0DATA3	FD Ø*T	00555	31050	50505		
•	00562		FD Ø*FILES	00556	13162	11230		
•	00563		-Ø	00557	77777	77777		
•	00564	INITIALJD	FD Ø*A	00560	06050	50505		
•	00565		U-TAG INITIAL2*INITIAL1	00561	00566	00562		
•	00566	INITIAL1	FD Ø*JULIA	00562	17322	11606		
•	00567		FD 2*N DAY	00563	23051	10636		
•	00570		-Ø	00564	05050	50505		
•	00571	INITIAL2	FD Ø*D	00565	77777	77777		
•	00572		-Ø INITIAL3	00566				
•	00573	INITIAL3	Ø	00567	77777	00570		
•	00574	INITIALDAT	FD Ø*A	00570	00000	00000		
•	00575		U-TAG INITIAL11*INITIAL10	00571	06050	50505		
•	00576	INITIAL10	FD 3*DAY ØF YEAR	00572	00577	00573		
•	00577		-Ø	00573	11063	60524		
•	00600	INITIAL11	FD Ø*D	00574	13053	61206		
•	00601		-Ø INITIAL12	00575	27050	50505		
•	00602	INITIAL12	Ø	00576	77777	77777		
•	00603	RGHTASC	FD Ø*A	00577	11050	50505		
•	00604		Ø RAI	00600	77777	00601		
•	00605		FD Ø*D	00601	00000	00000		
•	00606		Ø RA2	00602	06050	50505		
•	00607		FD Ø*A	00603	00000	00620		
•	00610		Ø RA3	00604	11050	50505		
•	00611		FD Ø*D	00605	00000	00624		
•	00612		Ø RA4	00606	06050	50505		
				00607	00000	00625		
				00610	11050	50505		
				00611	00000	00627		

## SUNTRACK

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CARDS	LI	ID	LABEL	TA	STATEMENT	LOC	F	JKB	Y	NOTES
*		00613		FD	0*A	00612	06012	06012		
*		00614		0	RA5	00613	00000	00000		
*		00615		FD	0*X2B23	00614	35620	35620		
*		00616		0	RA6	00615	00000	00000		
*		00617		FD	0*A	00616	06050	06050		
*		00620		-0	RA7	00617	77777	00633		
*		00621	RA1	FD	3*RIGHT ASC	00620	27161	41531		
*		00622		-0		00621	05063	01005		
*		00623	RA2	0		00622	05050	05050		
*		00624	RA3	1505		00623	77777	77777		
*		00625		-0		00624	00000	00000		
*		00626		0		00625	00000	01505		
*		00626	RA4	0		00626	77777	77777		
*		00627	RA5	2205		00627	00000	00000		
*		00630		-0		00628	00000	02205		
*		00631	RA6	0		00629	77777	77777		
*		00632	RA7	30		00630	00000	00000		
*		00633		-0		00631	77777	77777		
*		00634	DLN	FD	0*A	00632	00000	00000		
*		00635		0	DLN1	00633	06050	00505		
*		00636		FD	0*D	00634	00000	00000		
*		00637		0	DLN2	00635	00000	00000		
*		00640		FD	0*A	00636	00000	00000		
*		00641		0	DLN3	00637	11050	50505		
*		00642		FD	0*D	00638	00000	00000		
*		00643		0	DLN4	00639	00640	00640		
*		00644		FD	0*A	00641	06050	50505		
*		00645		0	DLN5	00642	00000	00660		
*		00646		FD	0*D	00643	11050	50505		
*		00647		0	DLN6	00644	00000	00662		
*		00650		FD	0*A	00645	06050	50505		
*		00651		-0	DLN7	00646	00000	00663		
*		00652	DLN1	FD	3*DECLINATION	00647	35620	76263		
*		00653		-0		00648	00000	00665		
*		00654	DLN2	0		00649	06050	50505		
*		00655	DLN3	1105		00650	77777	77777		
*		00656		-0		00651	00000	00000		

## SUNTRACK

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CARDS	L1 ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
• •	00657	DLN4	Ø	00662	00000	00000		
• •	00660	DLN5	72Ø5	00663	00000	07205		
• •	00661		-Ø	00664	77777	77777		
• •	00662	DLN6	Ø	00665	00000	00000		
• •	00663	DLN7	52	00666	00000	00000		
• •	00664	GMT	-Ø	00667	77777	77777		
• •	00665	GMT	Ø	00670	06050	50505		
• •	00666	Ø	Ø*D	00671	00000	00706		
• •	00667	Ø	Ø*D	00672	11050	50505		
• •	00670	Ø	GMT2	00673	00000	00712		
• •	00671	Ø	Ø*A	00674	06050	50505		
• •	00672	Ø	GMT3	00675	00000	00713		
• •	00673	Ø	Ø*D	00676	11050	50505		
• •	00674	Ø	GMT4	00677	00000	00715		
• •	00675	Ø	Ø*A	00700	06050	50505		
• •	00676	Ø	GMT5	00701	00000	00716		
• •	00677	Ø	Ø*X2B23	00702	35620	76263		
• •	00700	Ø	GMT6	00703	00000	00720		
• •	00701	Ø	Ø*A	00704	06050	50505		
• •	00702	-Ø	GMT7	00705	77777	00721		
• •	00703	GMT1	Ø	00706	32231	63312		
• •			3*UNIVERSAL TIME	00707	27300	62105		
• •				00710	31162	21205		
• •				00711	77777	77777		
• •				00712	00000	00000		
• •				00713	00000	01505		
• •				00714	77777	77777		
• •				00715	00000	00000		
• •				00716	00000	02205		
• •				00717	77777	77777		
• •				00720	00000	00000		
• •				00721	00000	00030		
• •				00722	77777	77777		
• •				00723	06050	50505		
• •				00724	00731	00725		
• •				00725	11163	03106		
• •				00726	23101	20505		
• •				00727	06053	20505		
• •				00730	77777	77777		
• •				00731	35700	76270		

## SUNTRACK

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CARDS	L1	ID	LABEL	TA	STATEMENT	LOC	F	J	K	Y	NOTES
*	00725		INITIAL18	-J	INITIAL18	00732	77777	00733			
*	00726		INITIAL18	J		00733	000000	000000			
*	00727		INITIALBD	FD	0*A	00734	06050	050505			
*	00730		U-TAG	U-TAG	INITIAL20*INITIAL19	00735	00742	00736			
*	00731		INITIAL19	FD	3*OBJECT	00736	24071	71210			
*	00732			-J		00737	31050	00505			
*	00733		INITIAL20	FD	0*A	00740	05050	050505			
*	00734			-J	INITIAL21	00741	77777	77777			
*	00735		INITIAL21	3032230000		00742	06050	050505			
*	00736			-J		00743	77777	00744			
*	00737		MONTHPRINT	0		00744	30322	00000	FD	SUN	
*	00740			0061000000		00745	77777	77777			
*	00741			0062000000		00746	00000	00000			
*	00742			0063000000		00747	00640	00000			
*	00743			0064000000		00748	00650	00000			
*	00744			0065000000		00749	00660	00000			
*	00745			0066000000		00750	00670	00000			
*	00746			0067000000		00751	00670	00000			
*	00747			0070000000		00752	00700	00000			
*	00750			0071000000		00753	00710	00000			
*	00751			6160000000		00754	00760	00000			
*	00752			6161000000		00755	61610	00000			
*	00753			6162000000		00756	61620	00000			
*	00754		HALFDAY	1000000000		00757	10000	00000			
*	00755		REVSRADIAN	2427630154		00764	24276	30154	DEC		
*	00756		SRHIBIN	5600000002		00765	56000	000002			
*	00757		IGNORE	6000000000		00766	60000	000000			
*	00760		INTERRUPT	RJP STATUSCK		00767	65000	00367			
*	00761		REWINDN0	2010000002		00770	20100	000002	1 B	NO INT	
*	00762		IDENT	0001200000		00771	00012	000000	SUN		
*	00763		SRAD	3266677126		00772	32666	77126	DEC	13750.987815	43
*	00764		HRAD	1030124435		00773	10301	24435	DEC	200/PI	P1
*	00765		MINSRAD	2167643241		00774	21676	43241	DEC	/12	
*	00766		HDAY	1252525250		00775	12525	25250	DEC	8P1/120	
											8/

## FRACHTMAN\*7/14/64

## SUNTRACK

CARDS	L1 ID	LABEL	TA STATEMENT	LOC	F	J	K	B	Y	NOTES
*	00767	MDAY	2660266026					24	032	* 711111111829
*	00770	SDAY	2506000000					00	1440	0000000000
*	00771	SECSRAD	2304045527	00776	26602	66026	DEC			2E
*	00772	SARAD	3113343172	00777	25060	00000	DEC			86400.00000000
*	00773	AUDNMSEC	3515643656	01000	23040	45527	DEC	13P1/43200		0000000000
*	00774	RDRSEC	3021344241	01001	31133	43172	DEC			206264.81B11
*	00775	TW0PIE	3110375523	01002	35156	43656	DEC	800/PI		934.91B19
*	00776	SUNRAD	0000230432	01003	30213	44241	DEC			* 75851852B29
				01004	31103	75523	DEC	6/86400		0.2831853B26
				01005	00002	30432	DEC			* 0046555B24 SUN 696
								000		
	00777	YEARPRINT	0000746661	01006	00007	46661				
	01000		0000746662	01007	00007	46662				
	01001		0000746663	01010	00007	46663				
	01002		0000746664	01011	00007	46664				
	01003		0000746665	01012	00007	46665				
	01004		0000746666	01013	00007	46666				
	01005		0000746667	01014	00007	46667				
	01006		0000746670	01015	00007	46670				
	01007		0000746671	01016	00007	46671				
	01010	KEY	400000000	01017	40000	00000				
	01011	FIRSTDIFF	0	01020	00000	00000				
	01012	BETA	0	01021	00000	00000				
	01013	GAMMA	0	01022	00000	00000				
	01014	DELTA	0	01023	00000	00000				
	01015	EPSILON	0	01024	00000	00000				
	01016	FUNCTION	0	01025	00000	00000				
	01017	P	0	01026	00000	00000				
	01020	HALF	2000000000	01027	20000	00000				
	01021	DMINB	0	01030	00000	00000				
	01022	DMIN2CPLB	0	01031	00000	00000				
	01023	EP2BM2DMA	0	01032	00000	00000				
	01024	BESSEL	0	01033	00000	00000				
	01025		0	01034	00000	00000				

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## SUNTRACK

CARDS	LI	ID	LABEL	TA	STATEMENT	LUC	F	JKB	Y	NOTES
•	01026			0		01035	00000	00000		
•	01027			0		01036	00000	00000		
•	01030			0		01037	00000	00000		
•	01031	PSQMP		0		01040	00000	00000		
•	01032	PSQMP6		0		01041	00000	00000		
•	01033	THIRD		1252525252		01042	12525	25252		
•	01034	SIXTH		0525252525		01043	05252	52525		
•	01035	KENNEDY		0		01044	00000	00000		
•	01036	NUMBERIV		0		01045	00000	00000		
•	01037	F3ESSEL		0		01046	00000	00000		
•	01040			0		01047	00000	00000		
•	01041			0		01050	00000	00000		
•	01042			0		01051	00000	00000		
•	01043			0		01052	00000	00000		
•	01044	SETINTAD		0		01053	00000	00000		
•	01045	INTERPOL		0		01054	61000	00000		
•	01046			0		01055	10040	77766		
•	01047			0		01056	34010	01053		
•	01050			0		01057	12310	01053		
•	01051			0		01060	10000	00000		
•	01052			0		01061	11033	00000		
•	01053			0		01062	15030	01021		
•	01054			0		01063	12303	00411		
•	01055			0		01064	11033	00000		
•	01056			0		01065	15030	01022		
•	01057			0		01066	12303	00011		
•	01060			0		01067	11033	00000		
•	01061			0		01070	15030	01023		
•	01062			0		01071	11030	01023		
•	01063			0		01072	21030	01024		
•	01064			0		01073	15030	01030		
•	01065			0		01074	20030	01030		
•	01066			0		01075	15030	01033		
•	01067			0		01076	11030	01023		
•	01070			0		01077	20030	01021		
•	01071			0		01100	21030	01022		
•	01072			0		01101	21030	01022		
•	01073			0		01102	15030	01031		
•	01074			0		01103	60200	01255		
•	01075			0		01104	11030	01024		

## SUNTRACK

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CARDS	L1 ID	LABEL	TA	STATEMENT	LOC	F	JKB	Y	NOTES
*	011076		SUB	A*W(FIRSTDIF)	01105	21030	01020		
*	011077		SUB	A*W(BESSEL)	01106	21030	01033		
*	011080		STR	A*W(EP2BM2DMA)	01107	15030	01032		
*	011081	PARTIAL	ENT	Q*W(P)	01108	10030	01026		
*	011082		MUL	W(GAMMA)	01111	22030	01022		
*	011083		LSH	AQ*1	01112	07000	00001		
*	011084		STR	A*W(BESSEL+1)	01113	15030	01034		
*	011085		STR	A*W(BESSEL)*AP0\$	01114	15630	01033		
*	011086		JP	NEGBESSI	01115	61000	01357		
*	011087		LSH	AQ*29D	01116	07000	00035		
*	01110		SEL	CL*W(KEY)	01117	52030	01017		
*	01111	ST0R1	STR	A*W(FBESSEL)	01118	15030	01046		
*	01112		STR	A*W(FBESSEL+1)	01119	15030	01047		
*	01113		ENT	Q*W(P)	01121	15030	01026		
*	01114		MUL	W(P)	01122	10030	00001		
*	01115		ENT	B5*1	01123	22030	01026		
*	01116		RJP	LEFRND0FF	01124	12500	00001		
*	01117		SUB	A*W(P)	01125	65000	01373		
*	01120		STR	A*W(PSQMP)	01126	21030	01026		
*	01121		RSW	AQ*30D	01127	15030	01040		
*	01122		MUL	W(DMINB)	01130	03000	00036		
*	01123		RSW	AQ*1	01131	22030	01030		
*	01124		STR	A*W(BESSEL+2)*AP0\$	01132	03000	00001		
*	01125		JP	NEGBESS2	01133	15630	01035		
*	01126		LSH	AQ*29D	01134	61000	01362		
*	01127		SEL	CL*W(KEY)	01135	07000	00035		
*	01130	ST0R2	STR	A*W(FBESSEL+2)	01136	52030	01017		
*	01131		ENT	A*W(PSQMP)	01137	15030	01050		
*	01132		RSW	AQ*30D	01140	11030	01040		
*	01133		DIV	6*AZERO	01141	03000	00036		
*	01134		JP	REMAINDER	01142	23400	00006		
*	01135	LINC0LN	STR	Q*W(PSQMP6)	01143	61000	01257		
*	01136		ENT	Q*W(P)	01144	14030	01041		
*	01137		SUB	Q*W(HALF)	01145	10030	01026		
*	01140		MUL	W(PSQMP6)	01146	27030	01027		
*	01141		RJP	LEFRND0FF	01147	22030	01041		
*	01142		RSW	AQ*30D	01150	65000	01373		
*	01143		MUL	W(DMIN2CPLB)	01151	03000	00036		
*	01144		LSH	AQ*1	01152	22030	01031		
*	01145		STR	A*W(BESSEL+3)*AP0\$	01153	07000	00001		
*					01154	15630	01036		

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CARDS	LI ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
•	01146		JP NEGNESS3	01155	61000	01365		
•	01147		LSH AQ*29D	01156	07000	00035		
•	01154	ST0R3	SEL CL*W(KEY)	01157	52030	01017		
•	01151		STR A*W(FBESSEL+3)	01160	15030	01051		
•	01152		ENT A*W(EP2BM2UMA)*AN0T	01161	11530	01032		
•	01153		JP N0F0URTH	01162	61000	01252		
•	01154		ENT Q*W(PSQMP6)	01163	10030	01041		
•	01155		SUB Q*W(THIRD)	01164	27030	01042		
•	01156		MUL W(PSQMP)	01165	22030	01040		
•	01157		RJP LEFRND0FF	01166	65000	01373		
•	01160		RSH AQ*30D	01167	03000	00036		
•	01161		MUL W(EP2BM2DMA)	01170	22030	01032		
•	01162		RSH AQ*2	01171	03000	00002		
•	01163		STR A*W(BESSEL+4)*AP0S	01172	15630	01037		
•	01164		JP NEGNESS4	01173	61000	01370		
•	01165		LSH AQ*29D	01174	07000	00035		
•	01166		SEL CL*W(FBESSEL)	01175	52030	01017		
•	01167	ST0R4	STR A*W(FBESSEL+4)	01176	15030	01052		
•	01170		ENT A*W(FBESSEL)	01177	11030	01046		
•	01171		SEL CP*W(FBESSEL+2)	01200	51030	01050		
•	01172		JP FL0TEST1*AP0S	01201	60600	01271		
•	01173	N0FL01	ENT Q*W(BESSEL+2)	01202	10030	01035		
•	01174	FIX1	RPL Y+Q*W(BESSEL)	01203	34030	01033		
•	01175		ENT A*W(FBESSEL+2)	01204	11030	01050		
•	01176		RPL A+Y*W(FBESSEL)	01205	24030	01046		
•	01177		SEL CP*W(FBESSEL+3)	01206	51030	01051		
•	01200		JP FL0TEST2*AP0S	01207	60600	01313		
•	01201	N0FL02	ENT Q*W(BESSEL+3)	01210	10030	01036		
•	01202	FIX2	RPL Y+Q*W(BESSEL)	01211	34030	01033		
•	01203		ENT A*W(FBESSEL+3)	01212	11030	01051		
•	01204		RPL A+Y*W(FBESSEL)	01213	24030	01046		
•	01205		SEL CP*W(FBESSEL+4)	01214	51030	01052		
•	01206		JP FL0TEST3*AP0S	01215	60600	01335		
•	01207	N0FL03	ENT Q*W(BESSEL+4)	01216	10030	01037		
•	01210	FIX3	RPL Y+Q*W(BESSEL)	01217	34030	01033		
•	01211		ENT A*W(FBESSEL+4)	01220	11030	01052		
•	01212		RPL A+Y*W(FBESSEL)	01221	24030	01046		
•	01213		ENT Q*W(P)	01222	10030	01026		
•	01214		SUB Q*W(HALF)	01223	27030	01027		
•	01215		MUL W(DMINB)	01224	22030	01030		

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CARDS	LI ID	LABEL	TA STATEMENT	LOC	F	JKB	Y	NOTES
01216			B5*	01225	12500	00000		
01217			RJP LEFRNDØFF	01226	65000	01373		
01220			STR A*W(KENNEDY)	01227	15030	01044		
01221			ENT Q*W(PSQMP)	01230	10030	01040		
01222			ADD Q*W(SIXTH)	01231	26030	01043		
01223			MUL W(DMIN2CP LB)	01232	22030	01031		
01224			RJP LEFRNDØFF	01233	65000	01373		
01225			ADD A*W(KENNEDY)	01234	20030	01044		
01226			ADD A*W(GAMMA)	01235	20030	01022		
01227			STR A*W(NUMDERIV)	01236	15030	01045		
01230			ENT A*W(FBESSEL)*APØS	01237	11630	01046		
01231			JP MINUS	01240	61000	01246		
01232			LSH A*1*ANEG	01241	66700	00001		
01233			ENT A*W(BESSEL)*SKIP	01242	11130	01033		
01234			RPL Y+1*W(BESSEL)	01243	36030	01033		
01235		SUM	ADD A*W(Ø+B4)	01244	20034	00000		
01236			EXIT	01245	61010	01054		
01237		MINUS	LSH A*1*APØS	01246	66600	00001		
01240			ENT A*W(BESSEL)*SKIP	01247	11130	01033		
01241			RPL Y-1*W(BESSEL)	01250	37030	01033		
01242			JP SUM	01251	61000	01244		
01243		NØFØURTH	CL A*	01252	11000	00000		
01244			STR A*W(BESSEL+4)	01253	15030	01037		
01245			JP STRØ4	01254	61000	01176		
01246		DIFF4ZERO	STR Q*W(EP2BM2DMA)	01255	14030	01032		
01247			JP PARTIAL	01256	61000	01110		
01250		REMAINDER	JP CIVIL*QPØS	01257	60200	01265		
01251			STR A*A	01260	15040	00000		
01252			SUB A*3*APØS	01261	21600	00003		
01253			JP LINCØLN	01262	61000	01144		
01254			SUB Q*1	01263	27000	00001		
01255			JP LINCØLN	01264	61000	01144		
01256		CIVIL	SUB A*3*APØS	01265	21600	00003		
01257			JP LINCØLN	01266	61000	01144		
01260			ADD Q*1	01267	26000	00001		
01261			JP LINCØLN	01270	61000	01144		
01262		FLØTEST1	ENT A*W(FBESSEL)*ANE <sub>G</sub>	01271	11730	01046		
01263			ADD A*W(FBESSEL+2)*SKIP	01272	20130	01050		
01264			JP BØTHNEGI	01273	61000	01303		
01265			JP NØFLØ1*APØS	01274	60600	01202		

CARDS	LI ID	LABEL	TA STATEMENT	LOC	F	J	K	B	Y	NOTES
			SEL CL*W(KEY)	01275	52030	01017				
	01266		STR A*W(FBESSEL)	01276	15030	01046				
	01267		ENT Q*W(BESSEL+2)	01277	10030	01035				
	01270		ADD Q*1	01278	26000	00001				
	01271		RPL Y+Q*W(BESSEL)	01301	34030	01033				
	01272		JP FIX1+3	01302	61000	01206				
	01273	BOTHNEG1	ADD A*W(FBESSEL+2)	01303	20030	01050				
	01274		JP NØFLØ1*ANEG	01304	60700	01202				
	01275		SEL SET*W(KEY)	01305	50030	01017				
	01276		STR A*W(FBESSEL)	01306	15030	01046				
	01277		ENT Q*W(BESSEL+2)	01307	10030	01035				
	01300		SUB Q*1	01310	27000	20001				
	01301		RPL Y+Q*W(BESSEL)	01311	34030	01033				
	01302		JP FIX1+3	01312	61000	01206				
	01303	FLØTEST2	ENT A*W(FBESSEL)*ANEG	01313	11730	01046				
	01304		ADD A*W(FBESSEL+3)*SKIP	01314	20130	01051				
	01305		JP BOTHNEG2	01315	61000	01325				
	01306		JP NØFLØ2*APØS	01316	60600	01210				
	01307		SEL CL*W(KEY)	01317	52030	01017				
	01310		STR A*W(FBESSEL)	01320	15030	01046				
	01311		ENT Q*W(BESSEL+3)	01321	10030	01036				
	01312		ADD Q*1	01322	26000	00001				
	01313		RPL Y+Q*W(BESSEL)	01323	34030	01033				
	01314		JP FIX2+3	01324	61000	01214				
	01315	BOTHNEG1	ADD A*W(FBESSEL+3)	01325	20030	01051				
	01316		JP NØFLØ2*ANEG	01326	60700	01210				
	01317		SEL SET*W(KEY)	01327	50030	01017				
	01320		STR A*W(FBESSEL)	01330	15030	01046				
	01321		ENT Q*W(BESSEL+3)	01331	10030	01036				
	01322		SUB Q*1	01332	27000	00001				
	01323		RPL Y+Q*W(BESSEL)	01333	34030	01033				
	01324		JP FIX2+3	01334	61000	01214				
	01325	FLØTEST3	ENT A*W(FBESSEL)*ANEG	01335	11730	01046				
	01326		ADD A*W(FBESSEL+4)*SKIP	01336	20130	01052				
	01327		JP BOTHNEG3	01337	61000	01347				
	01330		JP NØFLØ3*APØS	01340	60600	01216				
	01331		SEL CL*W(KEY)	01341	52030	01017				
	01332		STR A*W(FBESSEL)	01342	15030	01046				
	01333		ENT Q*W(BESSEL+4)	01343	10030	01037				
	01334		ADD Q*1	01344	26000	00001				
	01335									

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CARDS	L1 ID	LABEL	TA STATEMENT	LOC	F	J	K	B	Y	NOTES
-	01336		RPL Y+Q*W(BESSEL)	01345	34030	01033				
-	01337	BOTHNEG3	JP FIX3+3	01346	61000	01222				
-	01340		ADD A*W(FBESSEL+4)	01347	20030	01052				
-	01341		JP N0FL03*ANEG	01350	60700	01216				
-	01342		SEL SET*WIKEY)	01351	50030	01217				
-	01343		STR A*W(FBESSEL)	01352	15030	01046				
-	01344		ENT Q*W(BESSEL+4)	01353	12030	01037				
-	01345		SUB Q*1	01354	27000	00001				
-	01346		RPL Y+Q*W(BESSEL)	01355	34030	01033				
-	01347		JP FIX3+3	01356	61000	01222				
-	01350	NEGNESS1	LSH AQ*29D	01357	07000	00035				
-	01351		SEL SET*W(KEY)	01360	50030	01017				
-	01352	NEGNESS2	JP ST0R1	01361	61000	01120				
-	01353		LSH AQ*29D	01362	07000	00035				
-	01354		SEL SET*W(KEY)	01363	50030	01017				
-	01355		JP ST0R2	01364	61000	01137				
-	01356	NEGNESS3	LSH AQ*29D	01365	07000	00035				
-	01357		SEL SET*W(KEY)	01366	50030	01017				
-	01360		JP ST0R3	01367	61000	01160				
-	01361	NEGNESS4	LSH AQ*29D	01368	07000	00035				
-	01362		SEL SET*W(KEY)	01369	50030	01017				
-	01363		JP ST0R4	01370	61000	01176				
-	01364	LEFRND0FF	ENTRY	01373	61000	00000				ENTER WITH B5 SET TO SHIFTS
-	01365		JP MIKE*ANEG	01374	60700	01400				
-	01366		LSH AQ*B5*QP0S	01375	07205	00000				
-	01367		ADD A*1	01376	20000	00001				
-	01370		EXIT	01377	61010	01373				
-	01371	MIKE	LSH AQ*B5*QNEG	01400	07305	00000				
-	01372		SUB A*1	01401	21000	00001				
-	01373		EXIT	01402	61010	01373				
-	01374	ROUND0FF	ENTRY	01403	61000	00000				ENTER WITH B5 SET TO SHIFTS
-	01375		JP MAX*ANEG	01404	60700	01410				
-	01376		RSW AQ*B5*QP0S	01405	03205	00000				
-	01377		ADD A*1	01406	20000	00001				
-	01400		EXIT	01407	61010	01403				
-	01401	MAX	RSW AQ*B5*QNEG	01410	03305	00000				
-	01402		SUB A*1	01411	21000	00001				
-	01403		EXIT	01412	61010	01403				
-	01404	YRREMAIN	0	01413	00000	00000				
-	01405	WHOLEYEAR	0	01414	00000	00000				

SUNTRACK

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CARDS	L1	ID	LABEL	TA	STATEMENT	LOC	F	JKB	Y	NOTES
*	01416	JULIANDAY	0			01415	00000	00000		
*	01417	IMPERIAL	0			01416	00000	00000		
*	01418	TAPEBLOCK	0			01417	00000	00000		
*	01419	SLØTBLOCK	0			01420	00000	00000		
*	01421	TAPESEARCH	0			01421	00000	00000		
*	01422	RAAD	0			01422	00000	00000		
*	01423	DECAD	0			01423	00000	00000		
*	01424	DISTAD	0			01424	00000	00000		
*	01425	RADIFAD	0			01425	00000	00000		
*	01426	DECDFAD	0			01426	00000	00000		
*	01427	DISTDIFAD	0			01427	00000	00000		
*	01428	SAFE	0			01428	00000	00000		
*	01429	AEPHEM	RESERVE	8630		01429	00000	00000		
*	01430	LASTEphem	0			01430	00000	00000		
*	01431	RESERVE	1			01431	00000	00000		
*	03170					03170	00000	00000		
*	03171					03171	00000	00000		
*	03172					03172	00112	30264		
*	03173					03173	00112	32007		
*	03174					03174	31050	00005		

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1. "Haystack Pointing System Ephemeris Tape Program", M. I. T. Lincoln Laboratory, Publication 1964-41. (In Preparation)
2. Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanac (Her Majesty's Stationery Office, London, 1961).
3. R. Butler and E. Kerr, An Introduction to Numerical Methods (Sir Isaac Pitman and Sons, Ltd., London).

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13. ABSTRACT <p>This memorandum describes the method used by the Haystack pointing computer program for obtaining the celestial coordinates of the SUN at any time.</p>		

14.

#### KEY WORDS

ASTRONOMY  
CELESTIAL  
COORDINATES  
COMPUTER  
PROGRAM  
SUN  
UNIVAC

LINK A		LINK B		LINK C	
ROLE	WT	ROLE	WT	ROLE	WT

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